



Morphological and Morphometrical Study of the Human Acetabulum and its Clinical Implications

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ABSTRACT

Background: The acetabulum is a cup-shaped depression on the hipbone. All three innominate elements, the ilium, ischium and pubis contribute to its formation unequally. The acetabular fossa articulates with the head of femur to form the hip joint.

Objectives: To document the relationship between the depth and diameter of the acetabulum and to describe the anterior acetabular ridge morphology.

Material and Methods: The study was conducted on 73 adult unpaired dry hipbones of unknown age and sex were assessed for two morphometric and one morphological character. The data of the acetabular depth and diameter was determined using Vernier calipers. The morphology of anterior acetabular ridge was evaluated and classified as curved, angular, straight and irregular.

Results: The mean diameter of acetabular cavity on right side was found to be 48.3 ± 3.4 mm and on the left side 48.9 ± 3.5 mm. The mean depth on right side was measured to be 27.1 ± 3.4 mm and on left side 27 ± 3 mm. We observed positive co-relation between the mean and standard deviation of total diameter and depth of acetabular cavity. The Curved shape anterior acetabular ridge was the most predominant type (41.1%) and the least type was straight shaped (5.5%).

Conclusion: The morphometric assessment of the acetabulum has a myriad of utilities for Anatomists, anthropologists, experts in forensic medicine and orthopaedic surgeons for better alignment of acetabular cup placement during total hip arthroplasty. Further, the anterior ridge morphology may be vital in diagnosing congenital acetabular dysplasia and during treatment of hip joint fractures.

Key Words: Acetabulum, Acetabular ridge, Morphology, Morphometric, Prosthesis, Dysplasia

INTRODUCTION

Age, stature, gender and ethnicity form the corner stone's of an individual's biological identity. The distinct morphology of the human hip bone not only helps attribute these parameters to establish a person's identity but is also fundamental from the orthopedic, anthropologic and forensic point of view¹.

The acetabulum is a deep cup shaped, hemispherical depression on the outer surface of the hipbone. All three innominate elements that is the ilium, ischium and pubis contribute to its formation unequally². The central part of the acetabulum consists of the acetabular fossa surrounded by a curved articular lunate surface, which articulates with the head of femur to form the hip joint the major weight bearing joint of the body³.

The shape of the acetabulum can be altered prenatally due to disruption in its development or during the postnatal period due to damage to the cartilage of lunate articular surface. Acetabular dysplasia is the most common developmental disorder of the hip bone, due to underdeveloped acetabulum, wherein acetabular roof remains shallow, superficial and vertically oriented. This results in smaller surface area for weight bearing and hence receives much larger force per unit area while walking and may lead to early degeneration which is the indication for hip arthroplasty⁴.

The anthropometric study of the acetabulum aids radiologists in diagnosing congenital hip dysplasia, and orthopaedicians for planning for an acetabular surgery, during hip arthroplasty and in the treatment of hip fractures.

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This study would also be beneficial in understanding the pathophysiology of the hip pathologies such as femoroacetabular impingement and preparing prosthesis of desirable sizes⁵.

The present study becomes all the more vital as acetabular dimensions show regional variations and the study is crucial to provide valuable parameters in the Indian population which would exterminate the catastrophic consequences of prosthetic loosening or dislocation⁶.

The aim and objectives of the present study would be

- To document the acetabular depth and diameter
- To demonstrate the relationship between the two parameters
- To describe the morphology of the anterior acetabular ridge

MATERIAL AND METHODS

The study was conducted on 73 dry adult hip bones of unknown gender and age collected from Department of Anatomy bone bank, Ramaiah Medical College, Bangalore. Bones with gross damage or anomalies were excluded from the study. Vernier calliper was employed for the accurate measurements.

Morphometric and Morphological features documented (Figure 1-4).



Fig 1: Measurement of maximum transverse diameter

Fig 2: Measurement of maximum vertical diameter

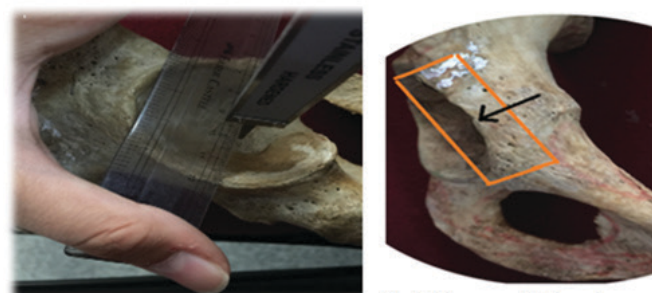


Fig 3: Measurement of depth of acetabulum

Fig 4: Arrow pointing at anterior acetabular ridge

Figure 1-4: Demonstrating various Morphometric and Morphological parameters measured.

- The transverse diameter of the acetabulum- The maximum distance between the anterior and posterior ends of the acetabular cavity.
- The vertical diameter of the acetabulum -The greatest dimension between the Upper and Lower Margins of the Acetabular Cavity.
- The total acetabular diameter - the average of the transverse and vertical diameter.
- The depth of the acetabulum - the maximum vertical distance from the deepest point in the acetabular cavity to the horizontal plane touching the margins of the acetabular cavity. A plastic ruler was kept across the margins of the acetabular cavity and the depth of the acetabulum was measured on the Vernier calliper from the deepest point in the acetabulum to the ruler.
- The shape of the anterior acetabular ridge was classified as curved, angular, straight and irregular. (**Fig 5**)
- The relationship between the acetabular depth and diameter was also evaluated.

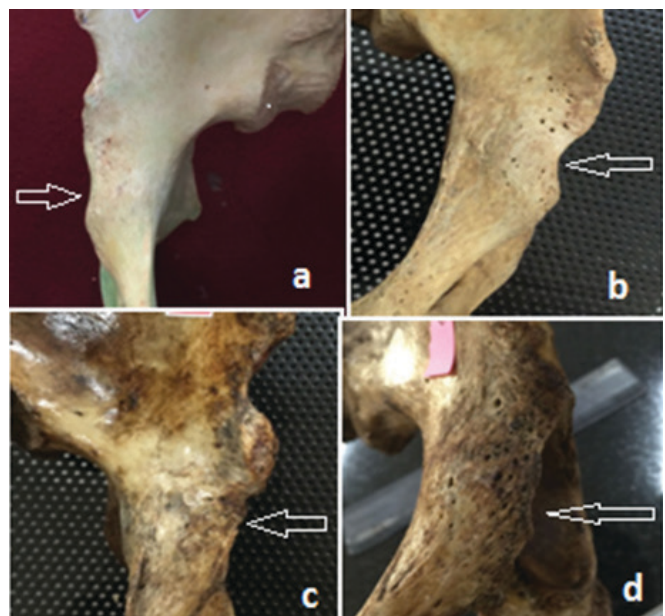


Figure 5: Types of anterior acetabular ridge a: Curved, b: Angular, c: straight, d: Irregular.

RESULTS

A comparison of 73 dry unpaired hip bones comprising 34 bones of left side and 39 bones of right side yielded the following results. Regarding the anterior acetabular ridge morphology, the commonest type was curved shape 31(41.10%), the least common was straight shape 4 (5.48%). (**Table 1**).

The mean values for acetabular diameter on right side was found to be $48.3 \pm 3.4\text{mm}$ and on the left side $48.9 \pm 3.5\text{mm}$.

The mean values for acetabular depth on right side was measured to be 27.1 ± 3.4 mm and on left side 27 ± 3 mm. (Table 2, 3). The mean and standard deviation of total diameter and

depth of acetabular cavity are shown and a significant positive co-relation was found between them.

Table 1: Comparison of shape of the anterior acetabular ridge on the right and left side

Shapes	Total No	Right side	Left side
Curved	30 (41.1%)	15 (38.5%)	15 (44.1%)
Angular	19 (26.2%)	11 (28.2%)	8 (23.5%)
Straight	4 (5.5%)	2 (5.1%)	2 (5.9%)
Irregular	20 (27.4%)	11 (28.1%)	9 (26.4%)

Table 2: Mean diameter and depth of the acetabular cavity

n=73	Transverse Diameter	Vertical Diameter	Total Diameter	Depth
Mean (mm)	47.2	49.9	48.6	27.1
Standard Deviation	3.3	3.7	3.5	3.2
Maximum	53.1	60.6	55.9	35.4
Minimum	40.3	40.6	40.7	20.1

$p=0.0001$ (Positive correlation between Total Diameter and Depth)

Table 3: Comparison of Total diameter and Depth of Acetabular cavity according to side

Variables	Total diameter		Depth	
	RIGHT(mm)	LEFT(mm)	RIGHT(mm)	LEFT(mm)
Mean	48.3	48.9	27.1	27.0
Standard Deviation	3.4	3.5	3.4	3.0
Maximum	54.6	55.9	35.4	32.4
Minimum	40.7	42.2	21.5	20.0

DISCUSSION

The acetabular morphology is very important for successful hip arthroplasty and for selecting a suitable prosthesis. The curved shaped acetabular ridges were found more frequently in our study. The comparison with other authors also showed same result. The percentage of irregular shape bones is significantly higher in the present study as compared to the study by Maruyama et al⁷. The percentage of bones with straight shape of anterior acetabular ridge is significantly lower as compared to the studies by Vyasa et al⁸, Prathiba et al⁹ and AKSU et al¹⁰ (Table 4).

The findings of measurements of Total Acetabular diameter and Depth of acetabular cavity in the present study are consistent with other studies (Table 5).

The knowledge of acetabular dimensions will help us in understanding the acetabular pathology and also in identifying disputed person through forensic expertise¹³.

The differences observed between the values of present study and that of other studies could be attributed to ethnic and racial variations.

Table 4: Comparison of shape of anterior acetabular ridge morphology with other studies

Authors	Maruyama et al ⁷	Vyasa et al ⁸	Prathiba Kareddy et al ⁹	AKSU et al ¹⁰	Govsa et al ¹¹	Present study
Shape						
Curved	60.5%	37.5%	38.2%	46.1%	43.3	41.1%
Angular	25.5%	12.5%	11.5%	16.8%	28.3%	26.0%
Irregular	4.5%	18.4%	28%	13.6%	16.3%	27.4%
Straight	4.5%	31.6%	38%	23.3%	11.9%	5.5%

Table 5: Comparison of Total acetabular diameter and depth with other studies

Authors	Diameter of acetabulum (cm)		Depth of acetabulum (cm)	
	Right	Left	Right	Left
Dhindsa et al ¹	5.1	5.0	2.6	2.6
Vyas et al ⁸	4.8	4.8	2.7	2.6
Prathibha Kareddy et al ⁹	4.8	4.7	3.0	3.0
Chauhan et al ¹²	4.7	4.7	2.7	2.8
Present study	4.9	4.8	2.7	2.7

However, it should be kept in mind, that the present study employed smaller number of hip bones, so it is worthwhile to perform similar studies on more number of hip bones for its theoretical and practical value in the coming years.

CONCLUSION

The findings of our study are vital for the accurate design of side specific prosthetic cups that replicate the curvaceous acetabular profile which would prevent prosthetic overlap, mechanical loosening and reduce the incidence of ilio-psoas impingement. The precise knowledge about the variations in morphology and morphometry of acetabular cavity would help clinicians, orthopedic surgeons, prosthetic surgeons and radiologists for better understanding about the pathologies of hip region which aids in accurate diagnosis and in planning a suitable treatment.

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